REMARKS

Claims 1, 15, 24, 32, 43, 45 and 48 have been amended. Claims 4-5, 18-19, and 27-28 have been cancelled. Support for the amendments can be found, for example at pages 3-4 and 8 of the specification. No new matter has been added. Claims 1-3, 6-17, 20-26, and 29-48 are pending.

Rejections under 35 U.S.C. § 102(b)

Claims 1-3, 9, 15-17, 22, 24-26, and 30 have been rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,606,163 to Huston et al. ("Huston"). Claims 1, 15, and 24 are independent. Claims 2-3 and 9 depend from claim 1, claims 16-17 and 22 depend from claim 15, and claims 25-26 and 30 depend from claim 24.

Applicants have discovered a method of sensing temperature, a temperature sensor, and a temperature-sensing coating that includes a semiconductor nanocrystal. **The semiconductor nanocrystal is overcoated with a second semiconductor material and has an organic or organometallic overlayer, the overlayer making the nanocrystal soluble in a binder.** See independent claims 1, 15 and 24.

Huston does not describe a semiconductor nanocrystal that is **overcoated with a second semiconductor material**. Nor does Huston describe a semiconductor nanocrystal having an **organic or organometallic overlayer**. For at least these reasons, Huston does not anticipate claim 1, claim 15 or claim 24, nor the claims that depend from it. Applicants respectfully request reconsideration and withdrawal of this rejection.

Rejections under 35 U.S.C. § 103(a)

Huston in view of Bawendi

Claims 4, 10-14, 18, 23, 27 and 31 have been rejected under 35 U.S.C. § 103(a) as being obvious over Huston in view of U.S. Patent No. 6,322,901 to Bawendi et al. ("Bawendi"). Claims 4 and 10-14 depend from claim 1, claims 18 and 23 from claim 15, and claims 27 and 31 from claim 24.

Applicants have discovered a method of sensing temperature that includes providing a temperature sensor including a matrix on a surface of a substrate. The matrix includes a

semiconductor nanocrystal in a binder. **The semiconductor nanocrystal is overcoated with a second semiconductor material and has an organic or organometallic overlayer, the overlayer making the nanocrystal soluble in the binder.** A portion of the sensor is irradiated with an excitation wavelength of light and the emission intensity of light from the sensor is detected. An unknown temperature of the surface of the substrate is determined directly from the emission intensity of light from the sensor. See claim 1.

Applicants have also discovered a temperature sensor that includes a matrix containing a semiconductor nanocrystal. The matrix is formed from a semiconductor nanocrystal and a binder. **The semiconductor nanocrystal is overcoated with a second semiconductor material and has an organic or organometallic overlayer, the overlayer making the nanocrystal soluble in the binder**. The sensor also includes a light source arranged to illuminate the semiconductor nanocrystal with a first wavelength of light, and a detector arranged to detect the intensity of a second wavelength of light emitted from the semiconductor nanocrystal. The second wavelength is longer than the first wavelength. See independent claim 15.

Applicants have also discovered a temperature-sensing coating comprising a matrix on a surface of a substrate, the matrix comprising a semiconductor nanocrystal in a binder. **The semiconductor nanocrystal is overcoated with a second semiconductor material and has an organic or organometallic overlayer, the overlayer making the nanocrystal soluble in the binder.** See independent claim 24.

Huston describes a system for measuring exposure to ionizing radiation, such as deep ultraviolet, x-rays and gamma rays. The system incorporates nanocrystals in a thermoluminescent material that emits light with an intensity related to the amount of ionizing radiation the material has been exposed to. The material is

> fabricated by deposition of the inorganic solid and the activators within a porous glass matrix. The deposition can be accomplished using known chemical methods for doping glasses, such as, for example, precipitation from a liquid phase solution, or CVD. Often, the most convenient method will be precipitation from a liquid phase solution. The exact deposition process used and the parameters employed for deposition are not critical, provided that the deposited materials are nanocrystalline and the glass

> retains its porosity. Generally, the size of the deposited crystals is controlled by the pore size of the glass into which the crystals are deposited. The pores restrict the growth of the deposited crystals so that the deposited crystals have a diameter smaller than that of the pore in which they precipitate.

See Huston at column 8, lines 5-20. It is clear that Huston's nanocrystals are formed in the presence of a porous glass, and that the size (i.e., diameter) of the nanocrystals is determined by the properties of the glass.

Bawendi relates to monodisperse populations of semiconductor nanocrystals and methods for preparing them. In particular, Bawendi describes that the preparation of semiconductor nanocrystals is

> accomplished by rapid injection of the appropriate organometallic precursor into a hot coordinating solvent to produce a temporally discrete homogeneous nucleation. Temporally discrete nucleation is attained by a rapid increase in the reagent concentration upon injection, resulting in an abrupt supersaturation which is relieved by the formation of nuclei and followed by growth on the initially formed nuclei. Slow growth and annealing in the coordinating solvent results in uniform surface derivatization and regularity in the core structure.... Both the average size and size distribution of the crystallites in a sample are dependent on the growth temperature.

See Bawendi at column 4, line 61-column 5, line 23. Bawendi further describes overcoating the nanocrystals with a second semiconductor material by introducing precursors into the coordinating solvent (see Bawendi at column 6, line 21-column 7, line 7). No porous glass is used in the preparation of the nanocrystals. Indeed, Bawendi teaches that nanocrystals prepared in this manner can be dispersed in solvents such as pyridine, methanol, aromatics and aliphatics (see Bawendi, for example, at column 7, lines 8-30).

The Examiner argues that "it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the method, the sensor and the matrix disclosed by Huston by replacing the semiconductor nanocrystal with the semiconductor nanocrystal disclosed by Bawendi." See the Office Action at page 4. Applicants respectfully disagree.

Huston teaches that the semiconductor nanocrystal is prepared by precipitation in the pores of a porous glass matrix. The semiconductor nanocrystal disclosed by Bawendi cannot be

formed in the pores of a porous glass matrix. See the Declaration of Moungi G. Bawendi, attached as Appendix A. **Accordingly, the semiconductor nanocrystals described in Huston cannot be replaced with the overcoated semiconductor nanocrystals of Bawendi.**

Moreover, a person of ordinary skill in the art would understand that it would be impossible to modify the method, the sensor and the matrix disclosed by Huston by replacing the semiconductor nanocrystal with a semiconductor nanocrystal overcoated with a second semiconductor material, as disclosed by Bawendi. As a result, the person of ordinary skill in the art would <u>not be motivated</u> to combine the references. Nor would the person of ordinary skill in the art have a <u>reasonable expectation of success</u>.

Applicants respectfully request that this rejection be reconsidered and withdrawn.

<u>Gouterman in view of Huston and Bawendi</u>

Claims 1-7, 9-20, 22-28, 30-36, and 38-48 have been rejected under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 5,341,676 to Gouterman et al. ("Gouterman") in view of Huston and Bawendi. See the Office Action at page 4. Claims 2-7 and 9-14 depend from claim 1. Claims 16-20 and 22-23 depend from claim 15. Claims 25-28 and 30-31 depend from claim 24. Claims 33-36 and 38-42 depend from claim 32. Claim 44 depends from claim 43; claims 46-47 depend from claim 45; and claim 48 is independent.

In the Office Action, the Examiner indicated that Gouterman teaches providing a temperature sensor including a fluorescent material, but does not teach the fluorescent material being a semiconductor nanocrystal. Huston, the Examiner alleges, teaches that semiconductor nanocrystals are luminescent when irradiated with light and are useful for sensing temperature. Finally, the Examiner indicates that Bawendi teaches semiconductor nanocrystals including an overcoat of a second semiconductor material. See the Office Action at pages 5-6.

Gouterman describes a fluorescent material that has a "fluorescent yield that is dependent on temperature." See Gouterman at column 9, lines 4-6. The fluorescence has an emission intensity that is related to temperature. As is well known, fluorescence refers to the emission of a second, longer wavelength of light by a material in response to illumination with an excitation wavelength. Applicants note that fluorescence can be distinguished from phosphorescence, for example by the time elapsed by illumination and emission.

Huston describes a thermoluminescent material. The thermoluminescent material can be made to emit light in response to heating (thermoluminesce) only **after the material is exposed to ionizing radiation**. As shown in Huston Fig. 2 (and described at column 4, lines 27-39), as the material is heated, the thermoluminescent emission varies. The integrated thermoluminescent signal is correlated to dose of ionizing radiation. See Huston at Fig. 3.

Huston discloses photoluminescence from the semiconductor nanocrystal (e.g., Fig. 1). However, Huston does not disclose that a semiconductor nanocrystal has a temperature dependent photoluminescence. Where Huston does describe an emission that varies with temperature, that emission is a thermoluminescent emission, and occurs without any excitation wavelength of light. See Huston, for example, at column 4, lines 27-39.

Huston states:

> Alternative heating methods include: an electrical heating source, thermochemical heating, inductive heating, or ultrasonic heating. Temperature measurement can be done optically if an ion such as europium is used in the dosimeter material. The relative peak heights and positions of the emission wavelengths are sensitive to temperature and can be used as a temperature measuring scheme.

See Huston at column 13, line 63 - column 14, line 5. However, Huston is describing temperature measurement using thermoluminescent emission. This statement fails to describe a measurement of temperature that relies on a photoluminescence emission.

Because Huston does not describe a measurement of temperature using photoluminescent emission, there is no motivation to combine Gouterman with Huston. Without a motivation to combine Gouterman with Huston, there is no motivation to combine Gouterman with Bawendi. Bawendi does not disclose any temperature dependent photoluminescence.

Applicants respectfully request that this rejection be reconsidered and withdrawn.

<u>Gouterman in view of Huston, Bawendi and alleged Prior Art</u>

Claims 8, 21, 29, and 37 have been rejected under 35 U.S.C. § 103(a) as being obvious over the combination of four references: Gouterman, Huston, Bawendi, and alleged Prior Art disclosed by the Applicants.

The Examiner has alleged that portions of the specification, in particular, page 8, lines 28 and 29, are Prior Art. In order to avoid using impermissible hindsight, the Examiner must "take[] into account only knowledge which was within the level of ordinary skill in the art at the time the claimed invention was made and does not include knowledge gleaned only from applicant's disclosure" (emphasis added). *In re McLaughlin*, 443 F.2d 1392, 1395, 170 USPQ 209, 212 (CCPA 1971). In this instance, the Examiner has improperly cited Applicant's own disclosure as prior art.

Furthermore, as discussed above, there is no motivation to make any combination of Gouterman, Huston, or Bawendi. An additional reference purporting to teach the elements of claims 8, 21, 29, and 37 that are missing from the combination of Gouterman, Huston, and Bawendi, would not cure this defect. Although Applicants have previously raised this issue (see the remarks filed on June 22, 2004), the Examiner has responded with silence.

Applicants respectfully request that this rejection be reconsidered and withdrawn.

CONCLUSION

Applicants ask that all claims be allowed. Please apply any charges or credits to deposit account 19-4293.

Respectfully submitted,

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